

PRELIMINARY DATA SUMMARY

May 1988

U.S. Army Engineer Waterways Experiment Station  
Coastal Engineering Research Center  
Field Research Facility  
Duck, North Carolina

## PRELIMINARY DATA SUMMARY

CERC Field Research Facility  
Duck, North Carolina

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Field Research Facility Measurement and Analysis Work Unit at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

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## PART I: INTRODUCTION

The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC's) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height 7.6 m above the National Geodetic Vertical Datum (NGVD). In addition, a main building contains offices, an instrument repair shop, and a data acquisition room.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local oceanographic and meteorological conditions. Bottom profiles along both sides of the pier and periodic bathymetric surveys are also performed.

This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Herman C. Miller at (919) 261-3511.

Part II presents the meteorological data; Parts III through VI present oceanographic data; Part VII presents nearshore profiles and bathymetry; and Part VIII, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used, their operational status during the month, and the data collection status. Figure 2 identifies the location of the instruments. The water depths at the wave gages and current meters vary and may be determined from information contained in Figure 7. Other installation information is contained in Table 1.

Times given in the report, unless otherwise specified, are referenced to eastern standard time (EST).

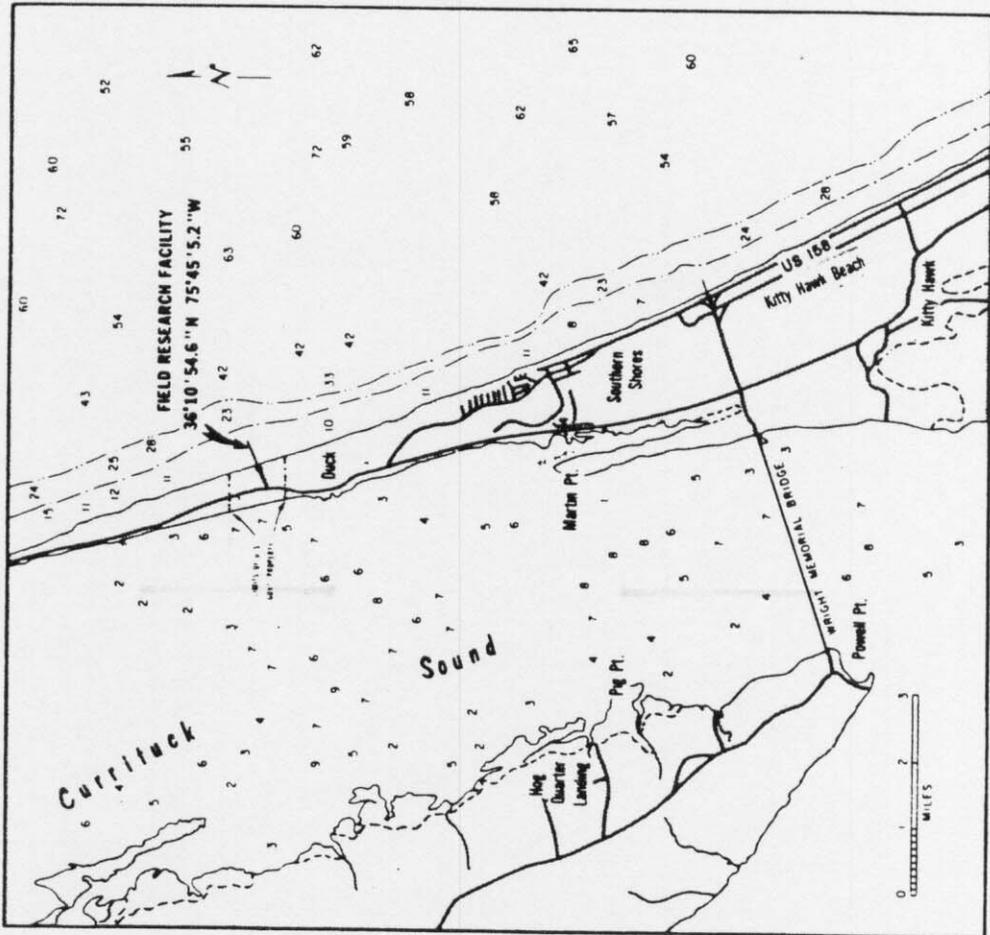
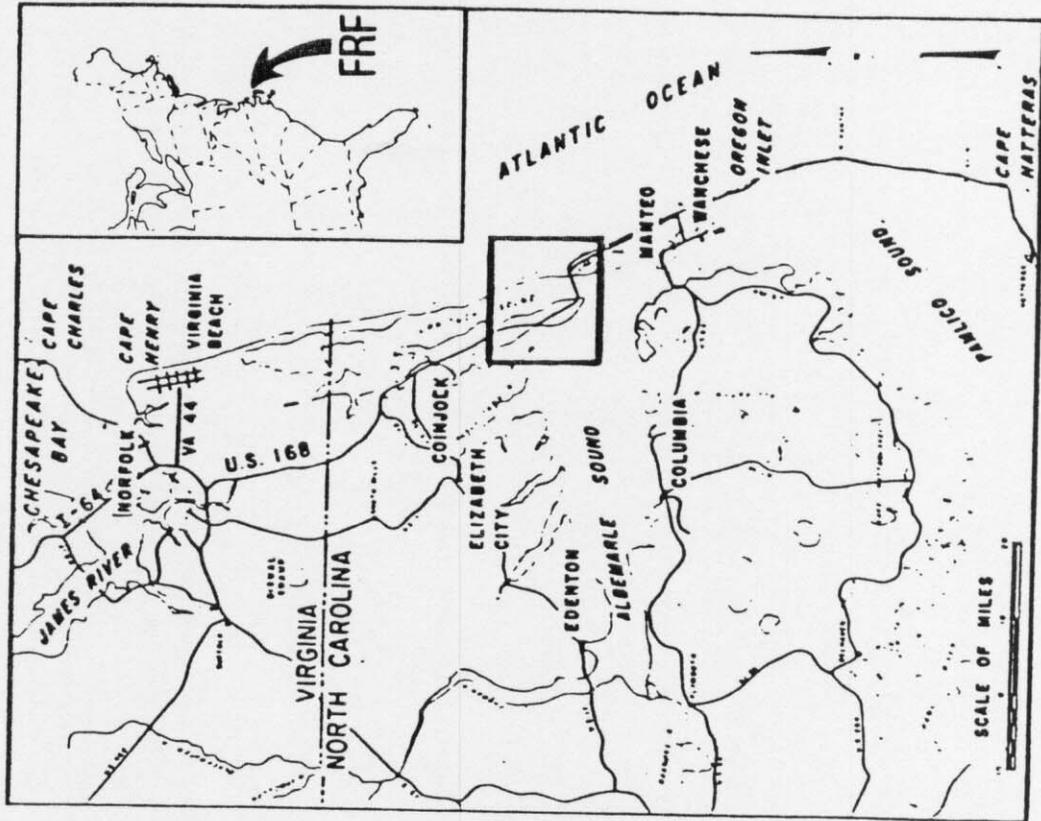


Figure 1. FRF location map

Table 1: Instrument Status/Data Availability

MAY 1988

Gage ID	Description/Remarks	Depth at Sensor		Day of the month																														
				1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 3 3																														
				1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
616	Barometric Pressure		Gage Status	*****																														
			Data Collected	***** / ** / - - / ** / *****																														
			Analog Record	*****																														
604	Precipitation		Gage Status	*****																														
			Data Collected	***** / ** / - - / ** / *****																														
624	Air Temperature		Gage Status	*****																														
			Data Collected	***** / ** / - - / ** / *****																														
632	Anemometer on Laboratory Building Elevation 19 m (NGVD)		Gage Status	*****																														
			Data Collected	***** / ** / - - / ** / *****																														
			Analog Record	*****																														
645	Baylor staff at station 7+80 on FRF pier	see Figure 7	Gage Status	*****																														
			Data Collected	***** / ** / - - / ***** /																														
625	Baylor staff at station 19+00 on FRF pier	see Figure 7	Gage Status	*****																														
			Data Collected	***** / ** / - - / *****																														
111	Pressure gage 309 m north of FRF pier (0.9 km offshore)	Approx. 7.8 m NGVD	Gage Status	*****																														
			Data Collected	***** / * / * / - - / * / *****																														
630	Waverider buoy 6.0 km offshore	Approx. 23 m NGVD	Gage Status	*****																														
			Data Collected	***** / * / * / - - / * / *****																														
679	Current meter 500 m south of FRF pier (0.5 km offshore)	see Figure 7	Gage Status	*****																														
			Data Collected	***** / * / * / - - / * / *****																														
865-1370	NOAA tide station at seaward end of FRF pier		Gage Status	*****																														
			Data Collected	*****																														
Supplemental Observations (daily oceanographic and meteorological observations)			Daily observation	*****																														

Gage Status	Daily Observation	Analog Record	Data Collected
Operational = *	Complete = *	Complete = *	All = *
Partial = /	Partial = /	Partial = /	Partial = /
Non-Operational = -	None = -	None = -	None = -

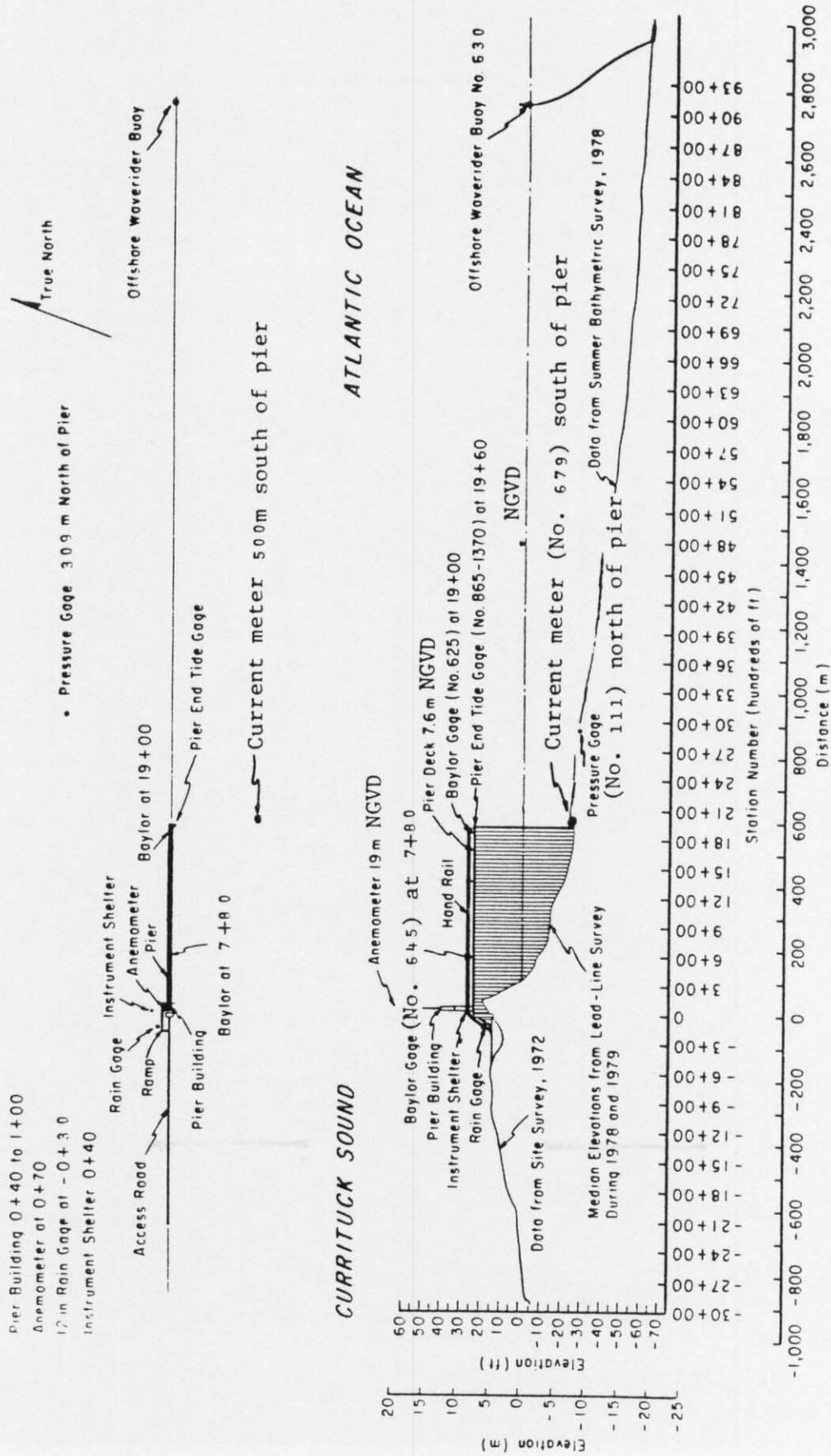


Figure 2. Instrument locations at FRF

## PART II: METEOROLOGICAL DATA

A variety of instruments have been installed at the FRF (Figure 2) to monitor the meteorological conditions. The data presented in Table 2 are collected and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750. For each instrument identified in Table 1 as having analog outputs, chart records are obtained, a log is maintained and the records are stored for future reference.

Winds were measured on top of the laboratory building at an elevation of 19 m (Figure 2) using a Weather Measure Skyvane anemometer.

Monthly resultant wind speeds and directions are determined by vector averaging the data. Temperature and atmospheric means are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 2 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in) -  
 $\text{mm} \times .03937 = \text{in}$
2. Millibars (mb) to inches of mercury (in Hg) -  
 $\text{mb} \times 0.02953 = \text{in Hg}$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -  
 $(\text{C} \times 9/5) + 32 = \text{F}$
4. Meters per second (m/s) to knots (kn) -  
 $\text{m/s} \times 1.943 = \text{kn}$

Table 2: Meteorological Data

MAY 1988

Day	Hour	Wind Speed	Wind Direction	Temperature		Atm Pressure	Precipitation
		m/sec	deg TN	deg C	mb	mm	
1	100	3	76	12.6	1017.5	0	
	700	3	56	13.4	1016.5	0	
	1300	7	44	13.0	1016.2	0	
	1900	6	49	12.1	1015.2	0	
2	100	3	40	11.7	1014.5	0	
	700	5	6	12.8	1015.9	0	
	1300	6	40	13.2	1016.9	0	
	1900	8	47	11.2	1018.2	0	
3	100	5	27	10.1	1019.6	0	
	700	4	21	11.0	1020.9	0	
	1300	6	100	12.7	1021.3	0	
	1900	8	19	12.0	1020.6	0	
4	100	7	22	13.8	1019.2	0	
	700	3	59	15.2	1018.2	0	
	1300	4	79	22.3	1016.9	0	
	1900	5	50	17.4	1016.5	0	
5	100	5	72	18.3	1015.2	0	
	700	5	52	16.5	1013.5	0	
	1300	3	18	15.5	1009.8	0	
	1900	2	61	16.2	1006.4	18	
6	100	4	67	14.3	1004.3	0	
	700	4	71	13.3	1003.7	0	
	1300	5	46	14.4	1003.3	0	
	1900	7	1	14.3	1004.3	0	
7	100	12	54	13.7	1005.0	0	
	700	10	47	15.0	1007.4	0	
	1300	14	15	15.6	1011.8	0	
	1900	8	35	13.6	1015.5	0	
8	100	6	56	13.0	1017.9	0	
	700	7	15	13.2	1021.6	0	
	1300	6	32	13.4	1024.0	0	
	1900	3	41	11.7	1023.0	0	
9	100	5	79	11.8	1021.9	0	
	700	3	97	13.3	1022.6	0	
	1300	7	14	16.6	1020.6	0	
	1900	6	71	18.8	1018.2	0	
10	100	6	97	18.8	1017.2	0	
	700	5	86	19.0	1016.5	0	
	1300	7	78	24.6	1013.1	0	
	1900	3	98	20.7	1012.8	0	
11	100	2	16	17.1	1011.1	0	
	700	3	70	17.0	1014.2	0	
	1300	3	41	23.5	1014.5	0	
	1900	6	50	17.4	1016.2	0	
12	100	3	56	15.7	1018.6	0	
	700	3	58	16.1	1021.6	0	
	1300	4	44	17.5	1023.0	0	
	1900	4	87	16.4	1023.0	0	
13	100	3	5	16.3	1022.6	0	
	700	2	11	18.8	1023.0	0	
	1300	3	11	22.7	1021.3	0	
	1900	3	83	23.0	1018.9	0	
14	100	3	9	21.6	1018.2	0	
	700	4	35	20.9	1017.9	0	
	1300	5	39	21.5	1017.5	0	
	1900	4	40	19.3	1015.9	0	
15	100	5	54	17.4	1016.2	0	
	700	4	48	15.9	1016.2	0	
	1300	7	16	16.7	1015.5	0	
	1900	7	14	16.6	1012.1	0	
16	100	6	37	16.4	1010.8	0	
	700	5	41	16.6	1011.1	0	
	1300	4	77	18.8	1010.4	0	
	1900	8	32	18.2	1007.7	0	

(Continued)

(Sheet 1 of 2)

Table 2: Meteorological Data

MAY 1988

Day	Hour	Wind	Wind	Temperature	Atm	Precipitation
		Speed m/sec	Direction deg TN	deg C	Pressure mb	mm
17	100	3	19	17.9	1008.4	17
	700	5	3	20.7	1010.1	0
	1300	Preventive Maintenance			1009.1	0
18	1900	5	33	22.3	1009.1	0
	100	8	28	18.4	1009.1	9
	700	4	91	20.0	1008.7	0
19	1300	4	9	21.3	1008.7	0
	1900	5	43	19.2	1008.4	0
	100	3	48	18.3	1009.1	0
20	700	2	53	19.1	1011.1	0
	1300	3	92	21.9	1012.1	0
	1900	4	46	19.0	1012.5	0
21	100	5	88	18.6	1012.8	0
	700	4	23	19.0	1014.2	0
	1300	5	34	24.5	1013.1	0
22	1900				1012.1	0
	100				1013.1	0
	700				1014.5	0
23	1300				1015.2	0
	1900	Operator Error			1014.2	0
	100				1014.2	0
24	700				1015.9	0
	1300				1014.5	0
	1900				1013.5	0
25	100				1013.5	0
	700	6	28	24.0	1015.2	0
	1300	4	45	29.2	1013.5	0
26	1900	7	100	27.0	1010.8	0
	100	7	30	23.8	1012.1	0
	700	6	2	21.9	1012.1	0
27	1300	4	63	27.8	1010.8	0
	1900	9	7	25.3	1008.4	0
	100	8	24	21.5	1007.7	0
28	700	9	30	21.9	1008.4	0
	1300	5	12	21.2	1008.4	0
	1900	6	52	12.9	1013.5	5
29	100	Software Error			1012.5	0
	700	11	18	12.9	1018.9	0
	1300	9	24	14.7	1020.3	0
30	1900	5	68	14.2	1020.9	0
	100	5	55	14.1	1021.6	0
	700	7	47	15.5	1023.0	0
31	1300	8	26	17.1	1022.6	0
	1900	9	52	15.7	1019.9	0
	100	11	48	15.9	1017.2	0
32	700	14	54	16.7	1015.5	0
	1300	6	66	20.1	1014.5	0
	1900	6	59	17.3	1014.8	0
33	100	5	46	17.1	1014.2	0
	700	8	56	18.1	1015.9	0
	1300	4	12	21.0	1016.2	0
34	1900	3	30	19.5	1015.5	0
	100	4	28	19.8	1016.5	0
	700	5	83	22.4	1017.9	0
35	1300	4	57	25.1	1017.9	0
	1900	3	42	20.8	1017.2	0
	100	3	20	22.0	1017.2	0
36	700	3	50	24.2	1016.9	0
	1300	3	46	28.6	1015.5	0
	1900	3	89	27.1	1013.5	0
		Resultant		Mean	Mean	Total
		5	43	17.9	1014.9	49

(Sheet 2 of 2)

### PART III: WAVE DATA

Wave data are collected from two Baylor staff gages (Gages 625 and 645), a pressure wave gage (Gage 111) and a Waverider buoy (Gage 630) as shown in Table 1 and Figure 2. The data are collected, analyzed, and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750 programmed to sample the wave gages every 6 hrs (more frequently during storms) near 0100, 0700, 1300, and 1900 EST. The sampling rate is two times per second for 34 minutes.

Wave height  $H_{m0}$  is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gage has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 deg of freedom calculated from a 34-min record. Peak wave period  $T_p$  is defined as the period associated with the maximum energy in the spectrum. When this analysis is complete, the data are written to magnetic tape.

Table 3 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 3 are average values computed from this data. Figure 3 is a time history of all  $H_{m0}$  and  $T_p$  values obtained for all gages.

Differences in wave periods between wave gages (Table 3 and Figure 3) may be the result of wave breaking, wave reformation, or the presence of multiple wave trains containing nearly equal energy.

Table 3: Wave Data

May 1988

Day	Hour	645		625		111		630	
		Baylor Hmo,m	at 7+80 T,sec	Baylor Hmo,m	at 19+00 T,sec	Pressure Hmo,m	Gage T,sec	Farshr Hmo,m	Wvrdr T,sec
1	0100	0.25	10.24	0.38	9.85	0.42	9.48	0.43	9.48
	0700	0.25	9.48	0.40	9.85	0.43	9.14	0.45	9.48
	1300	0.47	2.91	0.48	9.14	0.37	9.48	0.55	9.48
	1900	0.35	9.14	0.48	9.14	0.39	9.48	0.50	9.48
2	0100	0.31	2.72	0.44	9.14	0.42	9.14	0.48	8.53
	0700	0.33	9.14	0.49	10.67	0.49	8.53	0.58	8.26
	1300	0.39	10.24	0.54	9.48	0.56	9.85	0.64	8.83
	1900	0.68	3.88	0.91	3.82	0.85	4.13	0.97	8.53
3	0100	0.71	5.33	0.97	6.09	1.06	5.12	1.23	5.82
	0700	0.87	6.24	1.28	6.92	1.35	8.00	1.43	8.83
	1300	1.07	7.11	1.26	7.53	1.27	9.14	1.30	8.26
	1900	0.98	8.83	1.43	9.14	1.51	9.14	1.55	9.48
4	0100	0.86	10.24	1.44	9.85	1.49	10.24	1.65	10.24
	0700	0.74	9.48	1.33	9.85	1.59	11.13	1.53	10.67
	1300	0.61	11.13	1.11	9.85	1.19	10.24	1.31	10.24
	1900	0.51	10.67	0.95	10.67	1.11	10.67	1.19	10.67
5	0100	0.50	11.64	0.93	11.13	1.02	11.64	1.02	9.48
	0700	0.52	11.64	0.92	11.13	0.99	11.64	1.15	10.67
	1300	0.43	12.19	0.74	12.19	0.87	12.19	1.05	11.13
	1900	0.62	8.26	1.10	7.53	1.21	7.76	1.53	7.31
6	0100	0.49	8.26	0.96	8.26	1.09	8.26	1.27	8.53
	0700	0.43	8.00	0.89	7.76	1.09	7.76	1.19	7.76
	1300	0.45	8.00	0.84	8.53	0.93	8.83	1.00	8.26
	1900	0.65	3.61	1.04	8.53	1.03	8.53	1.22	8.53
7	0100	1.54	6.24	1.71	6.09	1.89	6.09	2.20	6.09
	0700	1.33	7.53	1.79	7.53	1.85	7.76	2.16	7.53
	1300	1.43	6.40	1.79	8.53	1.86	8.00	1.92	8.00
	1900	1.22	8.26	1.53	8.83	1.62	8.83	1.73	8.00
8	0100	1.13	9.14	1.42	9.48	1.41	8.26	1.63	8.83
	0700	1.05	9.48	1.31	9.48	1.34	9.14	1.34	8.53
	1300	1.03	9.85	1.40	9.85	1.39	9.85	1.53	9.48
	1900	1.25	10.24	1.63	9.85	1.74	11.64	1.84	11.64
9	0100	1.29	8.83	1.71	11.64	1.76	11.64	1.87	11.13
	0700	1.09	11.64	1.68	11.64	1.89	12.19	1.81	11.64
	1300	1.09	10.67	1.81	11.13	2.09	10.67	1.96	11.13
	1900	0.73	11.13	1.31	11.13	1.43	11.13	1.39	11.13
10	0100	0.55	10.67	1.02	10.67	1.26	10.67	1.20	11.13
	0700	0.40	10.24	0.82	9.85	0.93	10.67	0.97	9.85
	1300	0.44	9.85	0.83	9.48	0.90	9.85	0.99	9.85
	1900	0.30	9.85	0.73	9.48	0.68	9.85	0.78	9.48
11	0100	0.32	9.48	0.71	9.48	0.78	9.48	0.91	9.48
	0700	0.35	9.14	0.70	9.48	0.82	9.48	0.90	9.14
	1300	0.29	8.83	0.62	9.85	0.68	8.83	0.77	8.83
	1900	0.31	9.48	0.60	8.83	0.63	9.14	0.74	8.53
12	0100	0.37	7.76	0.67	7.53	0.69	8.53	0.80	7.31
	0700	0.29	2.69	0.49	7.53	0.53	8.83	0.62	7.11
	1300	0.27	14.22	0.50	6.92	0.54	8.00	0.64	6.40
	1900	0.35	2.69	0.53	8.00	0.48	8.26	0.57	9.14
13	0100	0.24	9.14	0.44	8.83	0.46	8.53	0.51	8.26
	0700	0.20	8.53	0.44	9.14	0.47	8.83	0.49	8.83
	1300	0.19	8.26	0.48	8.26	0.53	8.83	0.57	8.53
	1900	0.23	8.53	0.47	9.14	0.52	8.83	0.57	8.83
14	0100	0.16	8.83	0.41	8.53	0.49	8.83	0.58	8.83
	0700	0.23	8.53	0.42	8.83	0.51	8.26	0.60	8.53
	1300	0.19	8.00	0.42	7.76	0.50	8.26	0.54	8.26
	1900	0.22	8.53	0.39	8.83	0.42	8.53	0.52	8.83
15	0100	0.16	8.53	0.37	8.26	0.42	8.26	0.52	8.26
	0700	0.56	4.74	0.68	8.00	0.65	8.26	0.74	8.53
	1300	0.52	3.88	0.62	8.26	0.61	8.53	0.79	8.83
	1900	0.76	4.57	0.97	8.83	*		1.21	6.56
16	0100	0.81	8.83	1.22	8.83	*		1.56	8.83
	0700	0.59	4.27	1.00	8.83	*		1.25	7.76
	1300	0.38	4.20	0.74	9.14	*		0.89	8.26
	1900	0.46	3.88	0.81	8.26	0.80	8.53	0.96	8.53

\* Electronic problems

(Continued)

(Sheet 1 of 2)

Table 3: Wave Data

May 1988

Day	Hour	645		625		111		630	
		Baylor Hmo,m	at 7+80 T,sec	Baylor Hmo,m	at 19+00 T,sec	Pressure Hmo,m	Gage T,sec	Farshr Hmo,m	Wvrdr T,sec
17	0100	0.25	8.53	0.59	9.14	0.70	8.26	0.73	8.53
	0700	0.24	10.67	0.60	7.76	0.63	8.00	0.69	8.00
	1300	Preventive Maintenance							
18	1900	0.30	3.16	0.52	10.24	0.55	9.85	0.69	10.24
	0100	0.35	2.46	0.49	9.85	0.50	8.83	0.66	10.24
	0700	0.32	3.82	0.52	9.48	0.56	10.24	0.75	9.48
19	1300	0.23	6.74	0.47	8.00	0.55	9.48	0.69	7.53
	1900	0.41	6.92	0.65	7.11	0.74	6.24	0.86	5.95
	0100	0.43	7.11	0.81	7.53	0.91	7.31	1.10	6.56
20	0700	0.35	12.80	0.69	7.31	0.80	7.53	0.91	7.11
	1300	0.38	8.83	0.84	7.76	0.81	8.53	0.96	7.11
	1900	0.47	11.13	0.88	8.83	0.82	8.83	0.91	7.11
21	0100	0.56	6.74	0.94	9.85	0.95	9.48	1.00	8.26
	0700	0.72	7.31	0.99	7.76	1.08	7.11	1.16	7.53
	1300	0.62	7.31	0.85	7.31	0.87	7.31	1.01	7.31
22	1900	Operator Error							
	0100	Operator Error							
	0700	Operator Error							
23	1300	Operator Error							
	1900	Operator Error							
	0100	Operator Error							
24	0700	0.21	11.64	0.45	11.64	0.52	11.64	0.59	12.19
	1300	0.26	11.13	0.47	11.64	0.56	11.64	0.62	11.13
	1900	0.27	11.64	0.44	11.13	0.50	11.13	0.72	10.67
25	0100	0.20	11.13	0.39	10.67	0.46	10.67	0.62	11.13
	0700	0.19	10.67	0.40	11.13	0.48	11.13	0.56	10.67
	1300	0.29	10.24	0.42	10.67	0.44	10.24		*
26	1900	0.24	3.08	0.37	11.13	0.39	10.67	0.56	10.24
	0100	0.14	10.24	0.30	9.48	0.34	10.67	0.51	10.24
	0700	0.18	6.40	0.34	10.24	0.39	7.53	0.54	5.95
27	1300	0.25	5.33	0.39	5.12	0.43	5.22	0.46	5.02
	1900	1.28	5.57	1.12	5.45	1.24	5.45	1.29	5.69
	0100	1.13	5.69	1.17	5.33				*
28	0700	1.27	6.56	1.65	6.24	1.78	6.24	1.89	6.40
	1300	1.05	5.95	1.02	6.40	1.00	5.82	1.34	5.95
	1900	0.64	6.24	0.71	6.56	0.72	6.24	0.88	6.24
29	0100	0.58	5.57	0.63	6.09	0.65	6.24	0.64	5.82
	0700	0.57	5.57	0.69	5.69	0.62	3.33	0.77	6.09
	1300	0.57	3.24	0.79	4.00	0.77	7.31	0.91	6.74
30	1900	0.70	4.00	1.10	8.26	1.05	8.53	1.14	6.56
	0100	0.93	4.41	1.29	7.53	1.37	8.00	1.49	7.53
	0700	1.01	4.74	1.62	5.69	1.70	5.82	1.95	6.40
31	1300	0.90	6.92	1.41	7.31	1.58	8.00	1.88	7.11
	1900	0.73	4.41	1.16	8.83	1.18	8.83	1.37	8.53
	0100	0.85	4.83	1.05	8.83	1.06	9.14	1.19	9.48
32	0700	0.55	9.85	0.87	9.14	0.82	9.14	0.88	9.85
	1300	0.41	9.48	0.70	9.85	0.68	8.83	0.74	9.85
	1900	0.30	9.48	0.54	8.26	0.59	9.14	0.60	9.14
33	0100	0.23	9.48	0.51	8.83	0.52	9.14	0.56	8.00
	0700	0.22	8.83	0.44	8.00	0.49	8.83	0.48	8.53
	1300	0.20	7.76	0.43	7.76	0.47	8.00	0.46	9.14
34	1900	0.22	8.26	0.44	8.26	0.52	8.83	0.49	8.53
	0100	0.17	8.26	0.41	7.76	0.50	8.83	0.52	7.76
	0700	0.22	8.53	0.44	7.76	0.51	9.14	0.51	9.14
35	1300	*		0.42	8.83	*		0.47	8.83
	1900	*		0.44	8.83		8.53	0.50	9.14
Mean		0.54	7.86	0.83	8.69	0.90	8.76	0.98	8.62
Std dev		0.34	2.66	0.40	1.64	0.49	1.78	0.45	1.54

\* Electronic problems

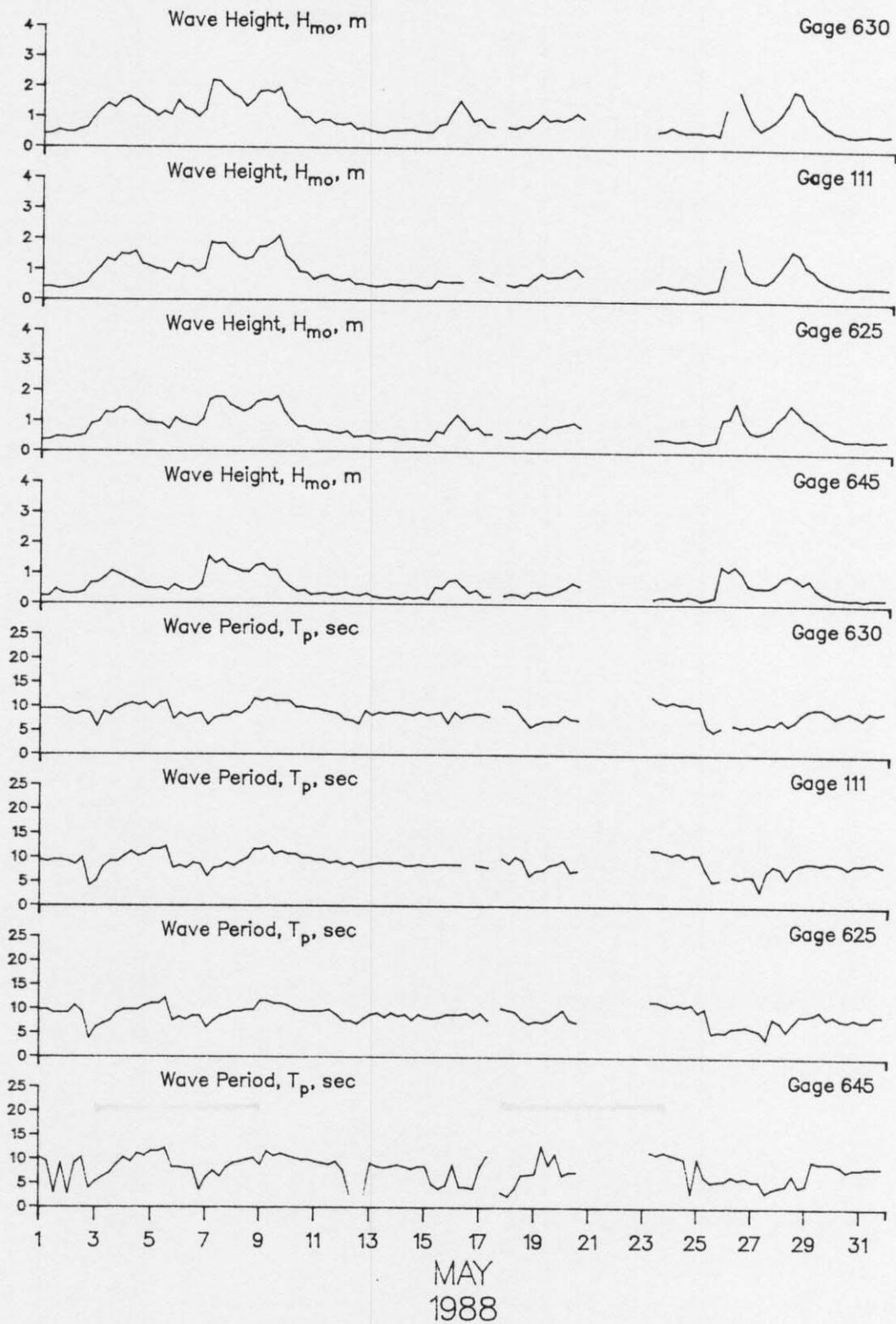


Figure 3. Time history of wave heights and periods

#### PART IV: CURRENT DATA

Current data (Table 4) are collected from a Marsh-McBirney electromagnetic biaxial current meter (Table 1 and Figure 2) and by visually observing the movement of dye on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier 12 m offshore.

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward).

All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the data.

Table 4: Current Data  
May 1988

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter at South Tripod Depth -4.8m (NGVD) ID #679	
			Dye at (579 m) (surface) Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface) Location	Speed	Dir	Speed
6	0100	Along Cross Result								5	N
										2	off
										5	2
6	0700	Along Cross Result	5	N	152	87	N	2	N	4	N
			1	off		35	off			1	on
			5	351		94	2			4	326
6	1300	Along Cross Result								2	N
										0	
										2	340
6	1900	Along Cross Result								3	S
										0	
										3	160
7	0100	Along Cross Result								41	S
										8	off
										42	149
7	0700	Along Cross Result	61	S	140	122	S			35	S
			0			18	off	no observation		4	off
			61	160		123	151			35	153
7	1300	Along Cross Result								38	S
										5	off
										38	153
7	1900	Along Cross Result								19	S
										2	off
										19	154
8	0100	Along Cross Result								12	S
										3	on
										12	174
8	0700	Along Cross Result	41	S	152	102	S	54	S	17	S
			0			0		North		0	
			41	160		102	160			17	160
8	1300	Along Cross Result								25	S
										4	off
										25	151
8	1900	Along Cross Result								12	S
										2	off
										12	151
9	0100	Along Cross Result								5	S
										4	off
										6	121
9	0700	Along Cross Result	0		177	0		16	S	9	S
			0			41	off	South		6	off
			0	0		41	70			11	126
9	1300	Along Cross Result								6	S
										1	on
										6	169
9	1900	Along Cross Result								2	N
										4	on
										4	277
10	0100	Along Cross Result								15	N
										8	on
										17	312
10	0700	Along Cross Result	61	N	152	51	N	50	N	16	N
			18	off		8	off	South		3	on
			64	357		51	349			16	329
10	1300	Along Cross Result								10	N
										4	on
										11	318
10	1900	Along Cross Result								15	N
										6	on
										16	318

KEY = All speeds in CM/SEC  
 N = Northward, Shore parallel  
 S = Southward, Shore parallel  
 on = onshore    off = offshore

Table 4: Current Data  
May 1988

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter at South Tripod Depth -4.8m (NGVD) ID #679		
			Dye at (579 m) (surface)		Dye at Mid-Surf Zone (surface)		Dye 12m offshore (surface)			Speed	Dir	
			Speed	Dir	Distance from Baseline (m)	Speed	Dir	Location	Speed			Dir
1	0100	-Along Cross Result									2 0 2	N  340
1	0700	-Along Cross Result	0 0 0		152	7 2 7	S on 177		North	8 S	0 0 0	
1	1300	-Along Cross Result									9 0 9	S  160
1	1900	-Along Cross Result									6 1 6	S off 151
2	0100	-Along Cross Result									0 0 0	
2	0700	-Along Cross Result	29 4 29	S on 169	140	13 2 13	S on 169		North	8 N	3 2 4	S off 126
2	1300	-Along Cross Result									5 4 6	S off 121
2	1900	-Along Cross Result									18 3 18	S off 151
3	0100	-Along Cross Result									15 3 15	S off 149
3	0700	-Along Cross Result	51 3 51	S on 163	152	38 8 39	S off 149		North	40 N	14 2 14	S off 152
3	1300	-Along Cross Result									15 6 16	S off 138
3	1900	-Along Cross Result									10 1 10	S on 166
4	0100	-Along Cross Result									0 0 0	
4	0700	-Along Cross Result	19 6 20	N off 357	152	76 15 78	N off 351		South	27 N	16 3 16	N on 329
4	1300	-Along Cross Result									7 1 7	S on 168
4	1900	-Along Cross Result									9 3 9	N on 322
5	0100	-Along Cross Result									3 1 3	N on 322
5	0700	-Along Cross Result	44 0 44	N  340	152	102 0 102	N  340		South	46 N	7 3 8	N on 317
5	1300	-Along Cross Result									6 0 6	N  340
5	1900	-Along Cross Result									11 2 11	N on 330

KEY = All speeds in CM/SEC  
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Table 4: Current Data  
May 1988

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter at South Tripod Depth -4.8m (NGVD) ID #679		
			Dye at (579 m) (surface) Speed	Dir	Dye at Distance from Baseline (m)	Speed	Dir	Location	Speed	Dir	Speed	Dir
11	0100	Along Cross Result									21 2 21	N on 335
11	0700	Along Cross Result	41 8 41	N off 351	140	61 9 62	N off 349	South	8	N	9 4 10	N on 316
11	1300	Along Cross Result									14 1 14	N off 344
11	1900	Along Cross Result									5 4 6	N off 19
12	0100	Along Cross Result									14 2 14	N on 332
12	0700	Along Cross Result	22 2 22	N on 334	140	36 11 37	N off 357	South	1	N	10 1 10	N off 346
12	1300	Along Cross Result									10 2 10	N on 329
12	1900	Along Cross Result									27 1 27	S off 158
13	0100	Along Cross Result									1 3 3	N on 268
13	0700	Along Cross Result	0 4 4	off 70	140	25 6 26	N off 354	South	8	S	6 0 6	S  160
13	1300	Along Cross Result									2 2 3	N on 295
13	1900	Along Cross Result									3 0 3	S  160
14	0100	Along Cross Result									5 1 5	N on 329
14	0700	Along Cross Result	12 12 17	N off 25	140	32 16 36	N off 7	North	32	N	2 1 2	N on 313
14	1300	Along Cross Result									7 2 7	N on 324
14	1900	Along Cross Result									1 2 2	S on 223
15	0100	Along Cross Result									3 0 3	S  160
15	0700	Along Cross Result	0 0 0	0	140	5 2 6	S off 143	North	9	N	4 0 4	S  160
15	1300	Along Cross Result									5 3 6	N on 309
15	1900	Along Cross Result									7 1 7	S off 152

KEY = All speeds in CM/SEC  
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Table 4: Current Data  
May 1988

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter at South Tripod Depth -4.8m (NGVD) ID #679		
			Dye at (579 m) (surface) Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface) Location	Speed	Dir	Speed	Dir
16	0100	Along Cross Result									21 1 21	S off 157
16	0700	Along Cross Result	51 8 51	S on 169	140	13 0 13	S  160	North	60	N	25 9 27	S off 140
16	1300	Along Cross Result									22 12 25	S off 131
16	1900	Along Cross Result									7 0 7	S  160
17	0100	Along Cross Result									9 3 9	S on 178
17	0700	Along Cross Result	11 8 14	N off 15	140	44 13 45	N off 357	South	21	N	2 1 2	N on 313
17	1300	Along Cross Result										
17	1900	Along Cross Result									8 3 9	N on 319
18	0100	Along Cross Result									3 0 3	N  340
18	0700	Along Cross Result	24 15 28	N off 11	128	17 8 19	N off 7	South	8	N	4 0 4	S  160
18	1300	Along Cross Result									6 1 6	S off 151
18	1900	Along Cross Result									6 1 6	N off 349
19	0100	Along Cross Result									4 4 6	S on 205
19	0700	Along Cross Result	3 2 4	S on 191	165	10 9 14	N off 22	South	49	N	11 3 11	S off 145
19	1300	Along Cross Result									7 10 12	S off 105
19	1900	Along Cross Result									6 2 6	S on 178
20	0100	Along Cross Result									4 2 4	S off 133
20	0700	Along Cross Result	0 0 0		165	41 12 42	N off 357	South	52	S	9 4 10	S off 136
20	1300	Along Cross Result									9 4 10	S off 136
20	1900	Along Cross Result										

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Table 4: Current Data  
May 1988

Day	Time	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter at South Tripod Depth -4.8m (NGVD) ID #679	
		Dye at (579 m) (surface)		Dye at Mid-Surf Zone (surface)		Dye 12m offshore (surface)			Speed	Dir
		Speed	Dir	Distance from Baseline (m)	Speed	Dir	Location	Speed	Dir	
21	0100-Along Cross Result									
21	0700-Along Cross Result	6 4 7	N off 11	152	41 2 41	N off 343	South	44	N	
21	1300-Along Cross Result									
21	1900-Along Cross Result									
22	0100-Along Cross Result									
22	0700-Along Cross Result	30 2 31	S on 163	140	51 5 51	N off 346	South	8	N	
22	1300-Along Cross Result									
22	1900-Along Cross Result									
23	0100-Along Cross Result									
23	0700-Along Cross Result	8 12 15	N off 36	140	61 37 71	N off 11	South	32	N	
23	1300-Along Cross Result									
23	1900-Along Cross Result									
24	0100-Along Cross Result									
24	0700-Along Cross Result	20 6 21	N off 357	140	76 23 80	N off 357	South	17	N	
24	1300-Along Cross Result									
24	1900-Along Cross Result									
25	0100-Along Cross Result									
25	0700-Along Cross Result	41 24 47	N off 11	152	30 3 31	N off 346	South	18	N	
25	1300-Along Cross Result									
25	1900-Along Cross Result									

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Table 4: Current Data  
May 1988

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter at South Tripod Depth -4.8m (NGVD) ID #679		
			Dye at (579 m) (surface) Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface) Location	Speed	Dir	Speed	Dir
26	0100	Along Cross Result										
26	0700	Along Cross Result	61 18 64	S on 177	152	102 30 106	S on 177	North	84	S	26 4 26	S off 151
26	1300	Along Cross Result									29 5 29	S off 150
26	1900	Along Cross Result									18 5 19	S off 144
27	0100	Along Cross Result									9 4 10	S off 136
27	0700	Along Cross Result	24 7 25	S on 177	140	18 0 18	S on 160	North	31	S	16 4 16	S off 146
27	1300	Along Cross Result									10 1 10	S off 154
27	1900	Along Cross Result									12 1 12	S off 155
28	0100	Along Cross Result									1 1 1	N on 295
28	0700	Along Cross Result	14 4 14	S on 177	146	51 23 56	N on 316	North	53	N	11 2 11	S off 150
28	1300	Along Cross Result									4 3 5	S off 123
28	1900	Along Cross Result									17 1 17	S off 157
29	0100	Along Cross Result									16 7 17	S off 136
29	0700	Along Cross Result	32 0 32	S on 160	152	32 0 32	S on 160	North	53		26 2 26	S off 156
29	1300	Along Cross Result									17 4 17	S off 147
29	1900	Along Cross Result									5 3 6	S on 191
30	0100	Along Cross Result									3 2 4	N on 306
30	0700	Along Cross Result	22 7 23	S off 143	128	0 0 0		no observation			7 2 7	S on 176
30	1300	Along Cross Result									17 7 18	S off 138
30	1900	Along Cross Result									2 4 4	N on 277

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Table 4: Current Data  
May 1988

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter at South Tripod Depth -4.8m (NGVD) ID #679		
			Dye at (579 m) (surface) Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Location	Speed	Dir	Speed	Dir
31	0100	-Along Cross Result									8	N
											1	on
											8	333
31	0700	-Along Cross Result	10	S		9	N				6	N
			9	off	128	3	off	South	53		3	off
			14	118		10	357				7	7
31	1300	-Along Cross Result									4	S
											2	on
											4	187
31	1900	-Along Cross Result									0	
											2	on
											2	250

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## PART V: SUPPLEMENTAL OBSERVATIONS

Visual wave direction measurements (Table 5) taken at the seaward end of the pier are made of both the primary wave train (i.e. that having the larger wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves). The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring the alignment of the wave crests. The pier axis (considered perpendicular to the beach at the FRF) is orientated 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and visibility are made daily at the seaward end of the FRF pier. A jar along with a thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The jar is removed, the temperature read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the surface visibility.

Table 5: Supplemental Observations

May 1988

Day	Time	Wave Approach Angle at Pier End deg from True N		Radar Wave Angle deg from True N	Width of Surf Zone,m	Water Characteristics at Pier End		
		Primary	Secondary			Temp.,C	Density g/cc	Secchi Vis.,m
1	0719	70			6	13.0	1.0234	2.1
2	0800	100	40	80	58	12.9	1.0228	3.0
3	0927	100	45	60	139	13.1	1.0222	2.1
4	0640	100	50		218	13.6	1.0227	0.9
5	0700	90	130		101	12.5	1.0244	0.9
6	0712	110	50		107	11.7	1.0246	0.6
7	0628	25		50	180	13.9	1.0229	0.3
8	0715	90	40	60	212	14.2	1.0213	0.3
9	0936	100	50	90	314	14.5	1.0208	1.2
10	0812	100			137	13.4	1.0236	0.9
11	0916	110			98	13.4	1.0240	1.2
12	0645	100			66	13.9	1.0234	2.1
13	0710	100			61	17.0	1.0194	2.1
14	1036	90	140		49	16.1	1.0234	1.5
15	0740	90			61	10.8	1.0228	2.4
16	0705	100	50		69	17.5	1.0210	1.8
17	0942	30	100		45	18.4	1.0214	2.4
18	0740	120	30		7	15.6	1.0230	2.1
19	0714	35	100		59	15.6	1.0230	3.0
20	0717	55	110		98	17.5	1.0222	2.7
21	0700	110	70		65	18.1	1.0222	2.4
22	0710	30	80		51	20.0	1.0204	4.0
23	0750	none	visible		54	20.0	1.0189	4.0
24	0707	90	150		61	15.9	1.0226	2.4
25	0700	40	100		52	13.9	1.0242	2.1
26	0715	40		50	152	12.8	1.0244	1.2
27	0715	40	70	50	66	17.2	1.0209	3.7
28	0655	90	50	90	141	17.5	1.0195	2.4
29	0830	45		60	91	17.6	1.0169	2.4
30	0705	none	visible		9	18.6	1.0186	3.4
31	0705	none	visible		5	20.0	1.0173	4.6

## PART VI: WATER LEVELS

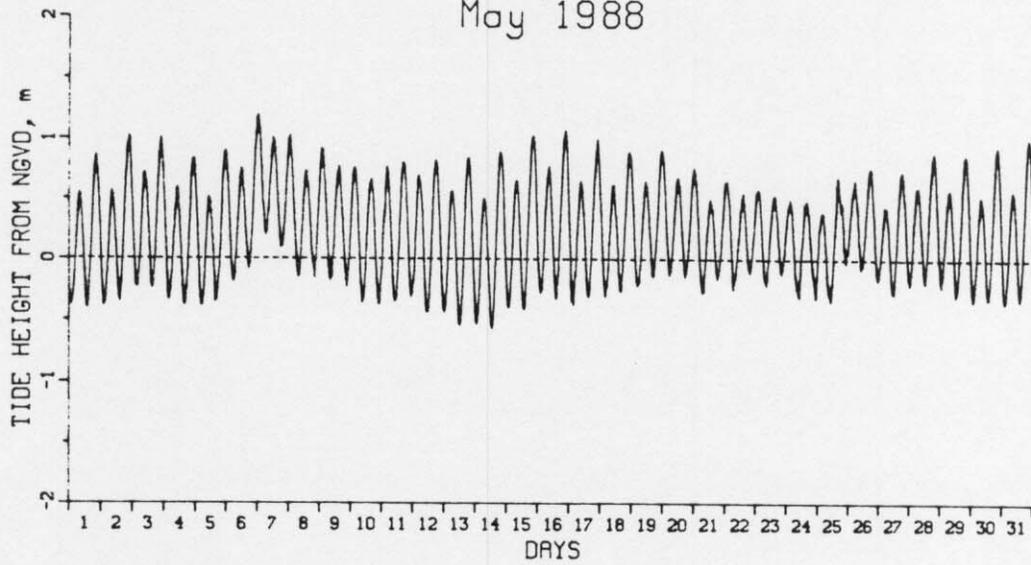
The National Ocean Services (NOS) has established a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A Leupold-Stevens digital recording float-type tide gage is used to collect data every 6 minutes throughout the month.

Figure 4 shows the variation in mean water levels computed over a tidal cycle period (12.42 hours) and contains a list of selected mean and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water levels.

Table 6 contains the time of the center of each sampling interval and the range, high, low, and mean water levels during each tidal cycle.

# FRF TIDE HEIGHTS

May 1988



## Monthly Water Levels, m NGVD

Extreme Low = -0.57 on day 14 at 1154 hr  
Extreme High = 1.19 on day 6 at 2306 hr  
Monthly Mean = 0.24  
Mean Low = -0.28  
Mean High = 0.74  
Mean Range = 1.02

Figure 4. Time history of mean water levels

Table 6: Water Levels, m NGVD

		May 1988			
Mid-Cycle Day	Time	Low	High	Mean	Range
1	612	-0.38	0.55	0.06	0.93
1	1837	-0.40	0.86	0.25	1.26
2	703	-0.38	0.56	0.08	0.94
2	1928	-0.35	1.01	0.38	1.36
3	753	-0.24	0.72	0.21	0.96
3	2018	-0.33	1.00	0.38	1.33
4	843	-0.37	0.59	0.09	0.97
4	2109	-0.37	0.83	0.25	1.19
5	934	-0.38	0.51	0.05	0.89
5	2159	-0.29	0.89	0.34	1.18
6	1024	-0.18	0.75	0.28	0.93
6	2249	-0.04	1.19	0.65	1.23
7	1115	0.09	1.01	0.56	0.91
7	2340	-0.11	1.02	0.50	1.13
8	1205	-0.15	0.73	0.29	0.88
9	30	-0.16	0.92	0.40	1.08
9	1255	-0.17	0.77	0.28	0.94
10	121	-0.26	0.76	0.27	1.01
10	1346	-0.36	0.66	0.16	1.02
11	211	-0.37	0.77	0.18	1.14
11	1436	-0.35	0.80	0.25	1.15
12	301	-0.37	0.69	0.17	1.07
12	1527	-0.43	0.82	0.21	1.25
13	352	-0.45	0.56	0.04	1.01
13	1617	-0.54	0.84	0.18	1.38
14	442	-0.53	0.50	-0.03	1.03
14	1707	-0.57	0.88	0.22	1.45
15	532	-0.40	0.65	0.11	1.05
15	1758	-0.41	1.02	0.36	1.44
16	623	-0.28	0.77	0.21	1.05
16	1848	-0.33	1.07	0.39	1.40
17	713	-0.37	0.65	0.13	1.03
17	1938	-0.30	1.00	0.36	1.31
18	804	-0.30	0.62	0.14	0.93
18	2029	-0.27	0.89	0.35	1.16
19	854	-0.21	0.65	0.20	0.87
19	2119	-0.14	0.91	0.41	1.05
20	944	-0.13	0.68	0.26	0.81
20	2210	-0.16	0.76	0.30	0.92
21	1035	-0.27	0.50	0.13	0.77
21	2300	-0.21	0.65	0.26	0.86
22	1125	-0.24	0.55	0.17	0.80
22	2350	-0.15	0.59	0.23	0.74
23	1216	-0.21	0.53	0.19	0.74
24	41	-0.24	0.50	0.16	0.74
24	1306	-0.30	0.49	0.13	0.79
25	131	-0.32	0.39	0.06	0.71
25	1356	-0.34	0.69	0.21	1.02
26	222	-0.05	0.66	0.30	0.72
26	1447	-0.08	0.77	0.34	0.84
27	312	-0.24	0.44	0.10	0.68
27	1537	-0.28	0.73	0.26	1.01
28	402	-0.21	0.60	0.21	0.81
28	1628	-0.19	0.89	0.37	1.08
29	453	-0.30	0.58	0.16	0.88
29	1718	-0.29	0.87	0.30	1.15
30	543	-0.34	0.53	0.07	0.87
30	1808	-0.32	0.94	0.33	1.26
31	634	-0.35	0.57	0.10	0.93
31	1859	-0.31	1.01	0.43	1.31

## PART VII: NEARSHORE PROFILES

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using the CRAB-Zeiss surveying system; a Zeiss Elta-2 first-order, self-recording electronic theodolite distance meter in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 5 shows the last survey in April and the survey in May on profile line 188, located 517 m south of the pier. The only significant change to the profile was a 60 m seaward migration of the nearshore bar (140 to 320 m). A slight flattening of the offshore slope (360 to 480 m) also occurred.

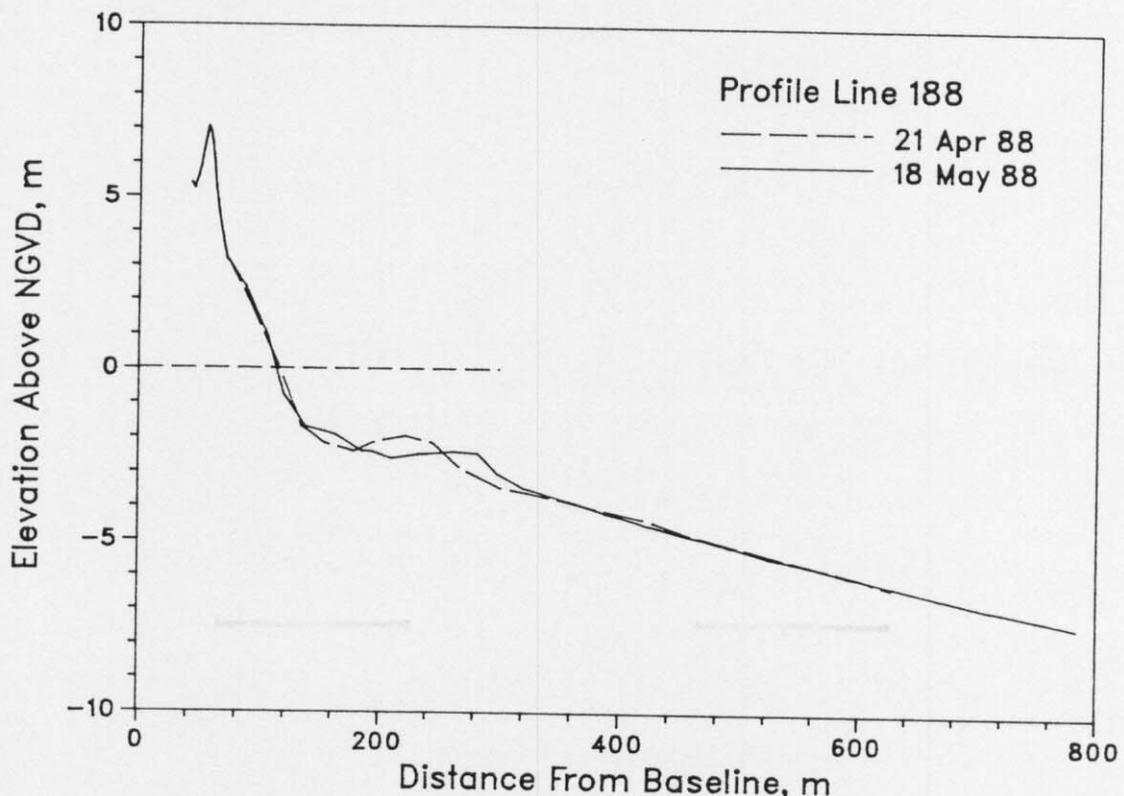


Figure 5. Monthly CRAB profiles on profile 188 - 517 m south of pier.

The profile envelope (Figure 6) reflects the maximum changes that occurred on the profile during 1988. Both changes are the result of the seaward movement of the nearshore bar.

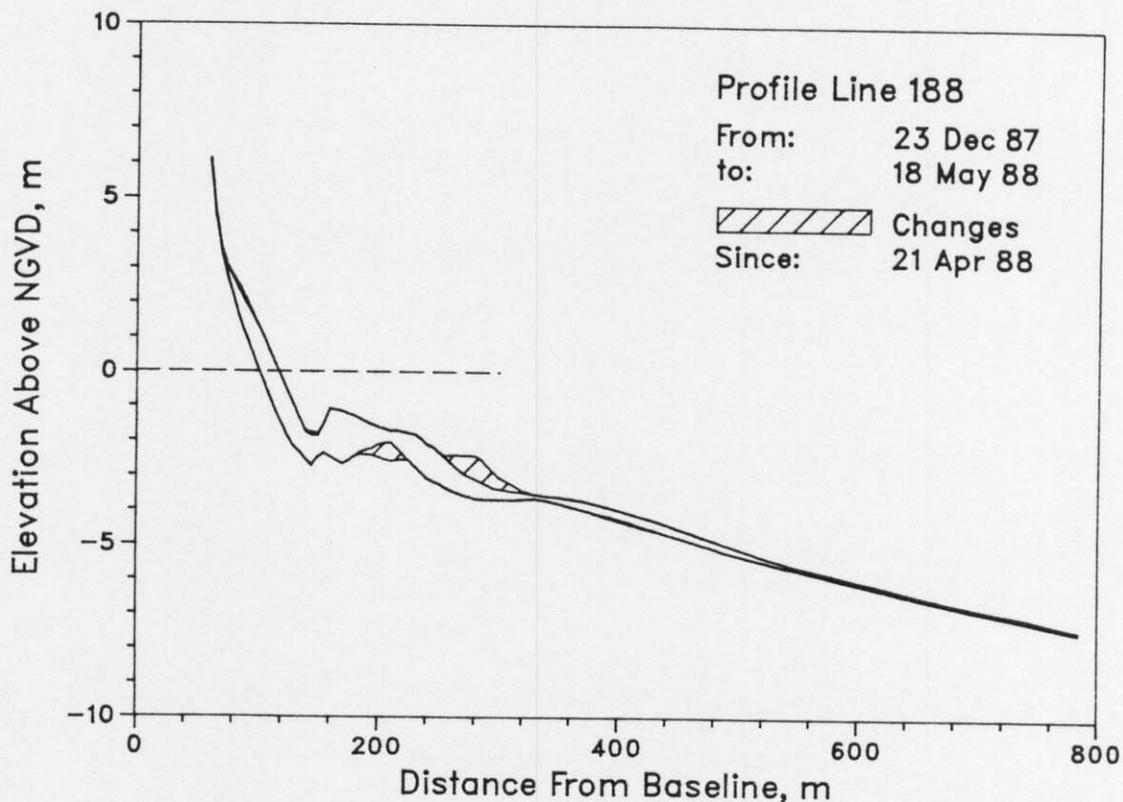


Figure 6. CRAB profile envelope - profile 188.

B. Bathymetry. No bathymetric survey was conducted in May. Figure 7 (April's survey) is given for reference.

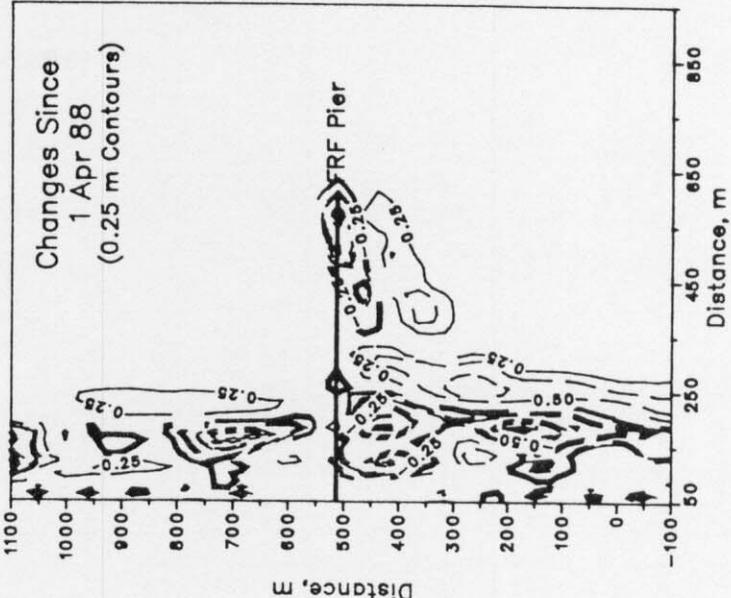
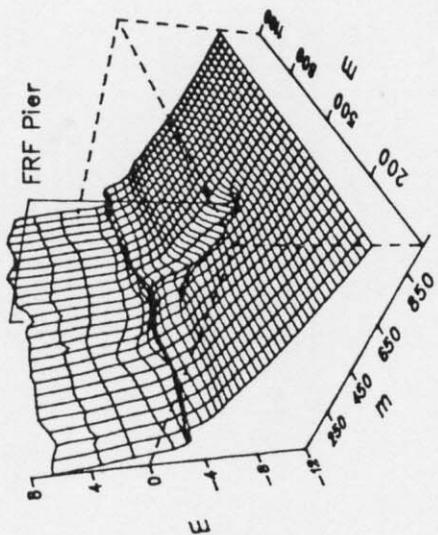
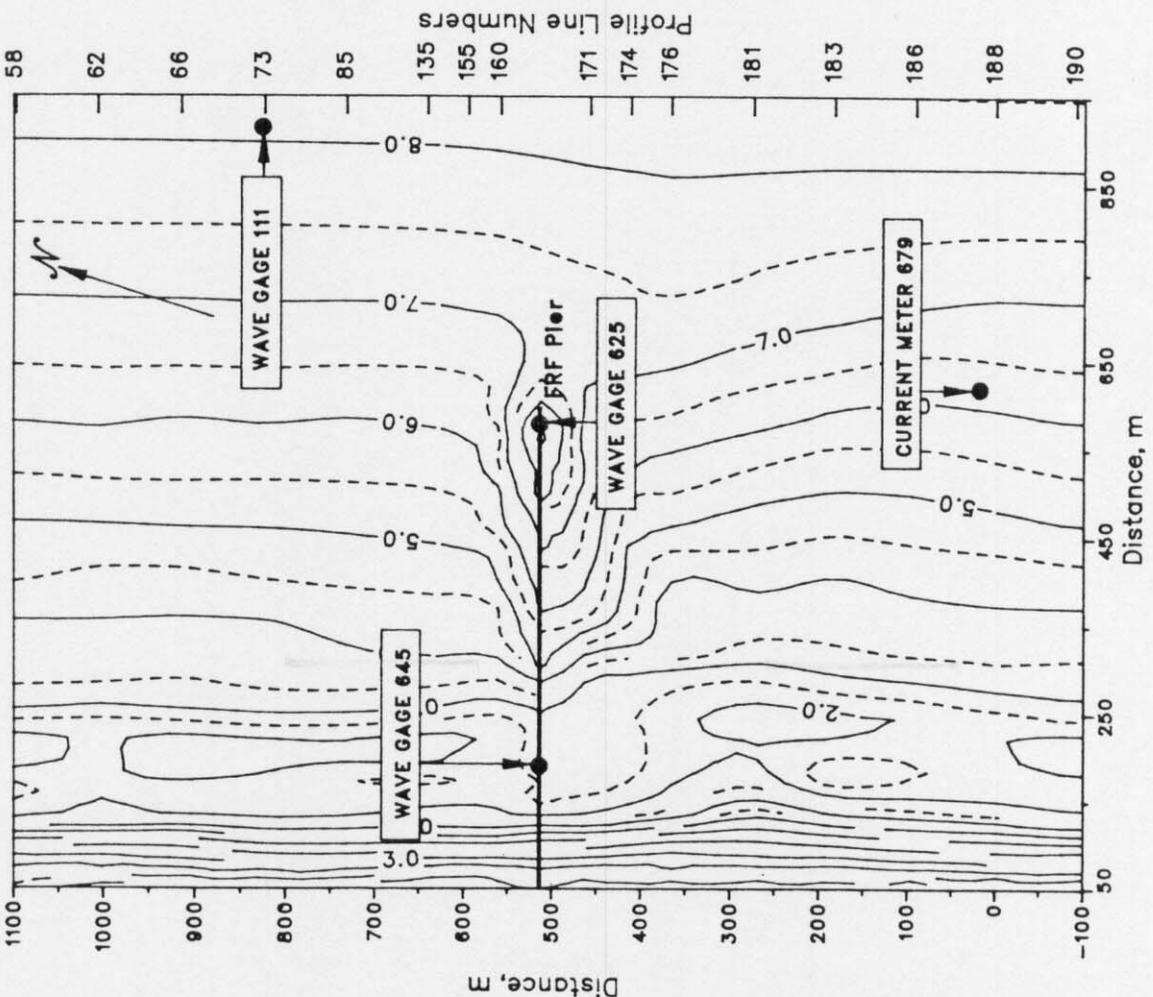


FIGURE 7 . FRF Bathymetry 21 Apr 88  
(Depths Relative to NGVD)

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